



HIIT: Current evidence and future application in cardiovascular rehabilitation

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Conflicts of Interest: None

Outline

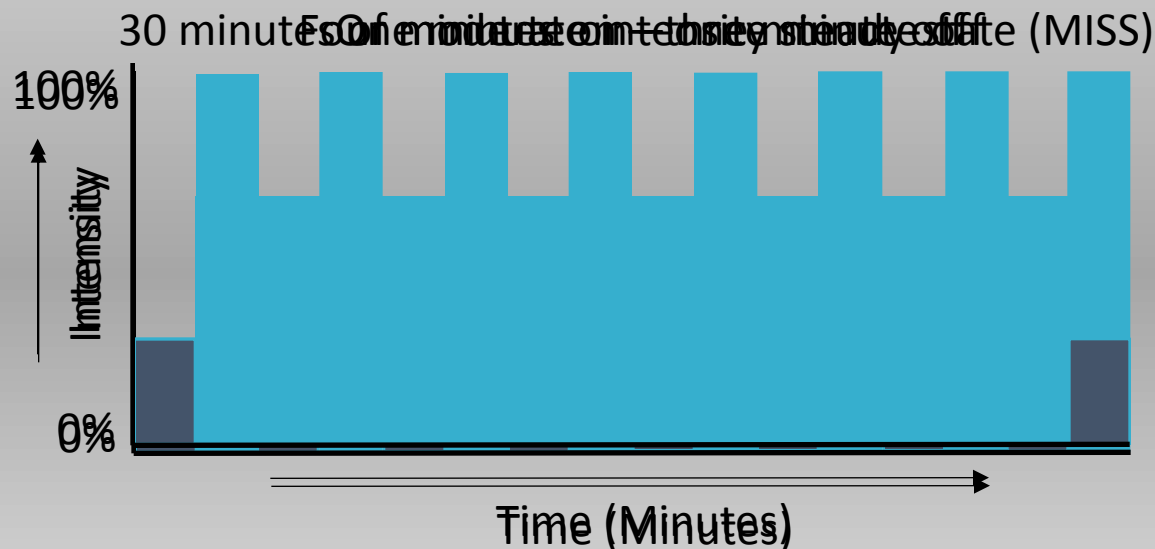
- Brief background of HIIT
- The aerobic fitness benefits(?) of HIIT
- HIIT in cardiac populations
- Emerging UK evidence

What is HIIT?

Repeat bouts of short duration high intensity exercise interspersed with short duration low intensity active recovery periods

Some disagreement in intensity zones - typically submaximal efforts >80% of maximal HR/>80 peak work rate

Variations in exercise volume/programme length



Where did HIIT come from?

Reported as early as the 1920s in athletic populations

1954 - Sir Rodger Bannister used HIIT during as a medical student during his lunch break - achieved the 4 minute mile

1960's peer-reviewed literature begins to emerge in healthy/athletic populations

1970/80's— Evidence for interval and high intensity interval training in clinical populations begins to emerge

1996 – Katerina Meyer found that interval training in CHF was safe – Assessed catecholamine, cardiac/metabolic stress, & dyspnoea - CHF patients can tolerate HIIT.

Today – A vast volume of literature on the efficacy of HIIT in health and disease

Is it safe?

Table 1. The number of patients, exercise-hours and the corresponding number of cardiovascular events associated with moderate- and high-intensity exercise, respectively.

Center	Patients (n)	Total training (hours)	Moderate-intensity (hours)	High-intensity (hours)
Ålesund	775	25 720 ¹	15 232	10 488 ¹
Feiring	2629	85 208 ²	63 032 ¹	22 176 ¹
Røros	1442	64 892	51 192	13 700
Total	4846	175 820	129 456	46 364
Event rates:				
Cardiac arrest, fatal			1	0
Cardiac arrest, non-fatal			0	2
Myocardial infarction			0	0
Risk of events		1/58 607	1/129 456	1/23 182

The likelihood of a cardiac event in high risk individuals appears to be low when conducting either moderate, or high intensity exercise

Is it Effective?

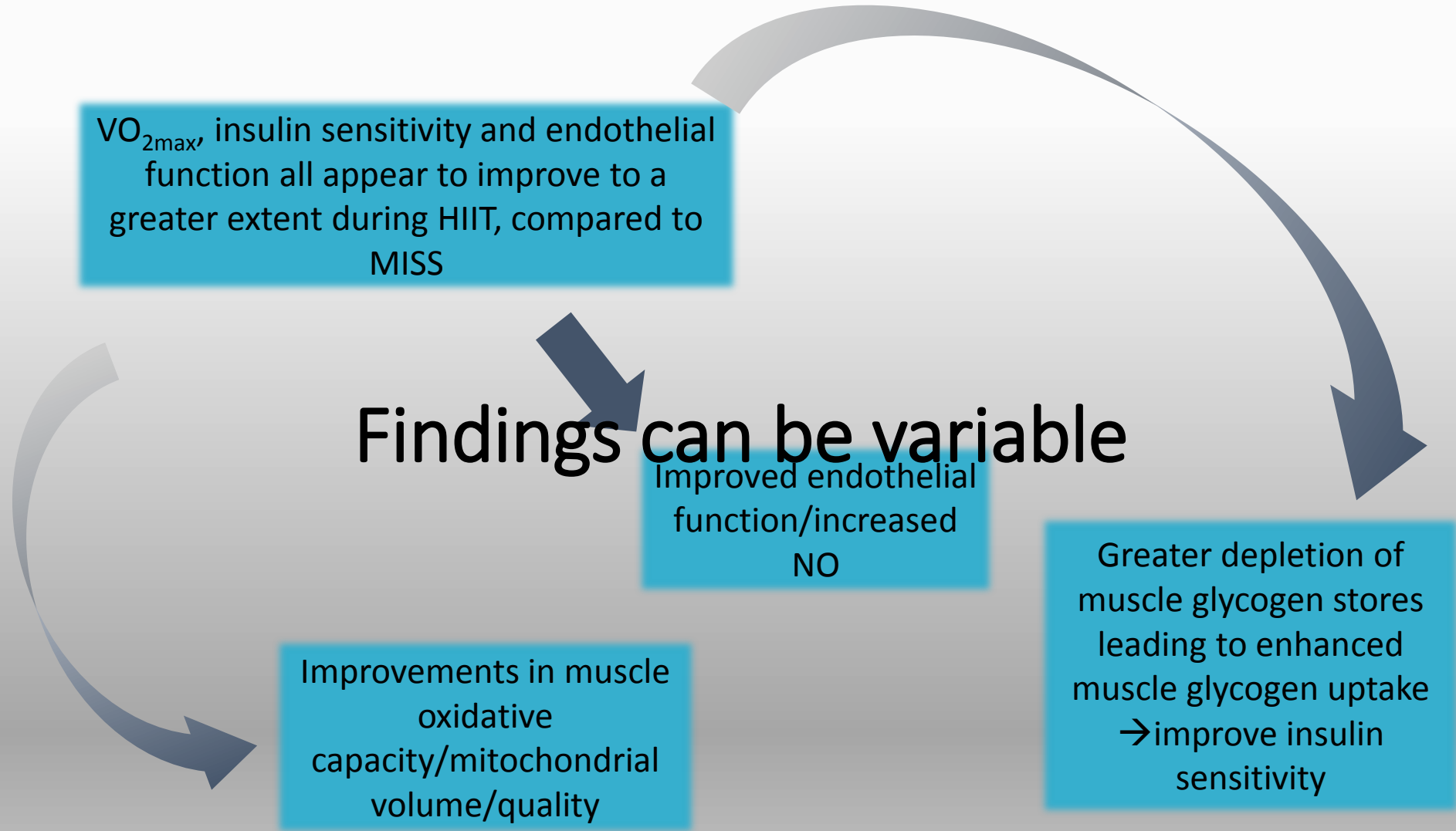
VO_{2max} , insulin sensitivity and endothelial function all appear to improve to a greater extent during HIIT, compared to MISS

Findings can be variable

Improved endothelial
function/increased
NO

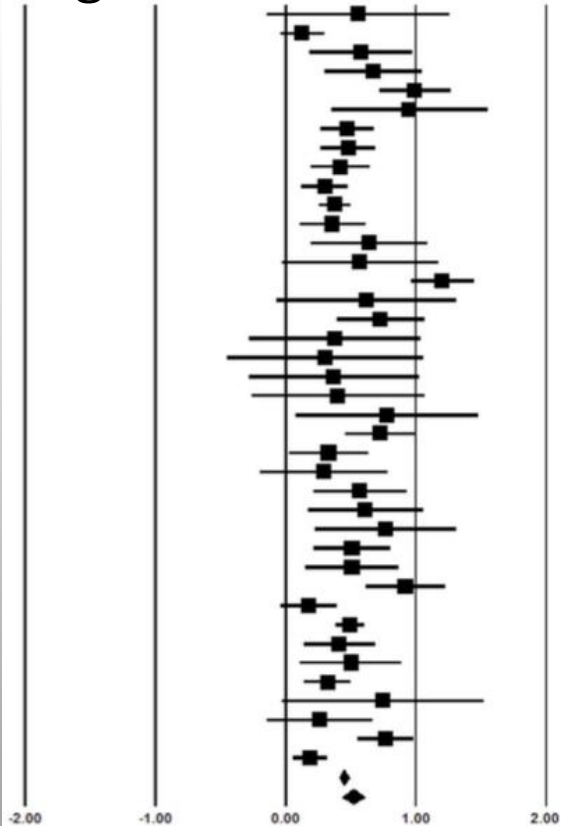
Improvements in muscle
oxidative
capacity/mitochondrial
volume/quality

Greater depletion of
muscle glycogen stores
leading to enhanced
muscle glycogen uptake
→ improve insulin
sensitivity



Is it Really Effective?

Higher Vol. — Bacon '13



Bacon et al (2013)

Favours HIIT 0.51 L/min (43 to 0.60 L/min) up to 0.9 L for longer studies

Lower Vol. — Weston '14

	Effect on VO _{2max} (%)		Inference
	Mean	±90 % CL	
Effect on treatment groups ^a			
Sedentary males	10.0	±5.1	Possibly moderate ↑
Sedentary females	7.3	±4.8	Likely small ↑
Active non-athletic males	6.2	±3.1	Likely moderate ↑
Active non-athletic females	3.6	±4.3	Possibly moderate ↑
Athletic males	2.7	±4.6	Unclear
Controls	1.2	±2.0	Unclear

Weston et al (2014)

Weston et al (2014)

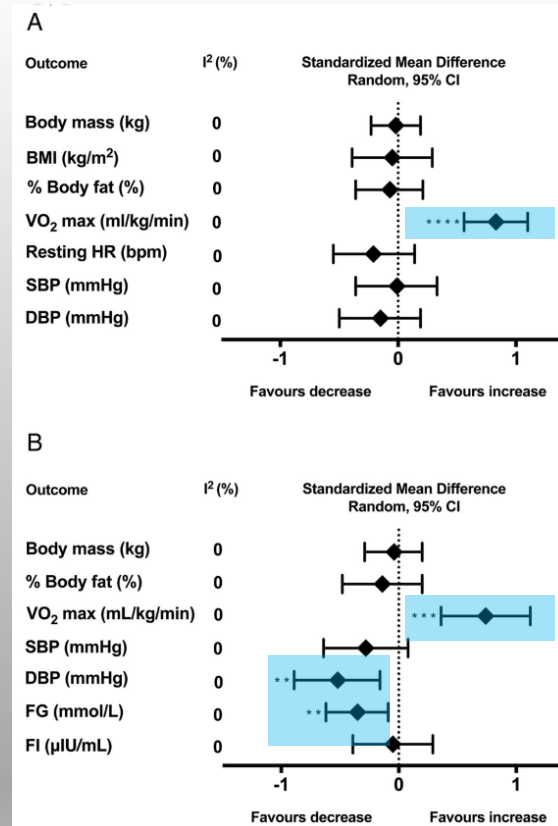
The effects of low vol. HIIT appear to favour less fit populations

There is no definitive consensus on whether HIIT is superior to *Well Prescribed* endurance exercise training apparently populations

HIIT and Cardiometabolic Health

The effects of short-term HIIT also favour less fit populations

Batacan '17



Similar to VO_{2peak}, HIIT appears more effective at improving cardiometabolic health when individuals are unfit or sedentary

Adaptations in sedentary individuals

Type	Frequency	Time	Intensity	Result
MISS	Exercise 3 x p/week for 8 weeks	Exercise progressed from 20 to 35 minutes	~60% PPO	VO_{2peak} - MISS 9% : HIIT 15% $a-VO_2$ diff – MISS ↑: HIIT ↑ Q_{max} : MISS ~ : HIIT ↑ VO_2 Kinetics - MISS~ : HIIT: ↑ Exhaustion Time - MISS↑: MISS↑ ↑ Capillary/Fibre R - MISS↑: MISS↑
HIIT			4 min low / 1 minute 90% PPO	

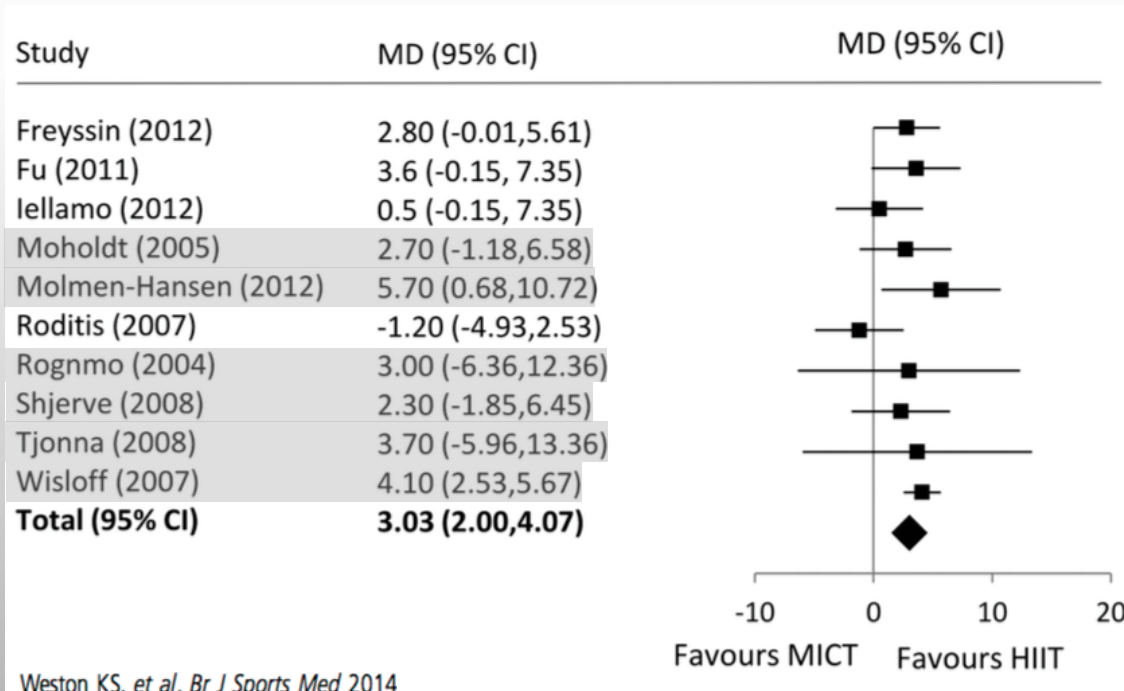
Effect of interval versus continuous training on cardiorespiratory and mitochondrial functions: relationship to aerobic performance improvements in sedentary subjects

Frédéric N. Daussin,¹ Joffrey Zoll,¹ Stéphane P. Dufour,¹ Elodie Ponsot,¹ Evelyne Lonsdorfer-Wolf,¹ Stéphane Doutreleau,¹ Bertrand Mettauer,^{1,2} François Piquard,¹ Bernard Geny,¹ and Ruddy Richard¹

¹CHRU of Strasbourg, Physiology and Functional Explorations Department, Civil Hospital, Strasbourg, France and University Louis Pasteur, Faculty of Medicine, Physiology Department, Strasbourg, France; and ²Cardiology Department, Civil Hospital, Colmar, France

So what might this mean for cardiovascular rehabilitation programmes?

Is HIIT Effective in Cardiac Populations?



Mean difference favours HIIT by 3.03 mL/kg/min (95% CI 2.00 to 4.07; $p < 0.001$)

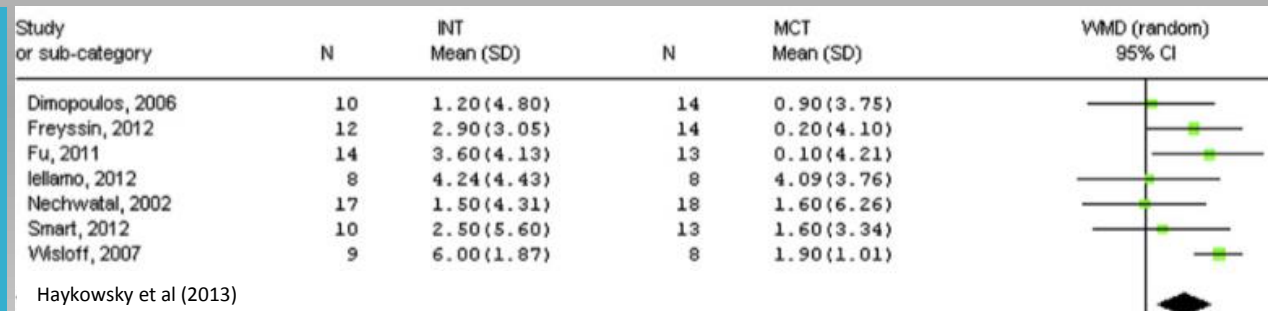
Six out of 10 studies conducted by the same research group

Only 273 patients included

Other systematic reviews/meta-analyses show similar results

Heart Failure Only

Mean difference favours HIIT by 2.14 mL/kg/min (95% CI 0.66 to 3.63)



The Clinical Significance?

$\text{VO}_{2\text{peak}}$ is one of the strongest clinical prognosticators. Improvements in $\text{VO}_{2\text{peak}}$ are consistently associated with improved survival:

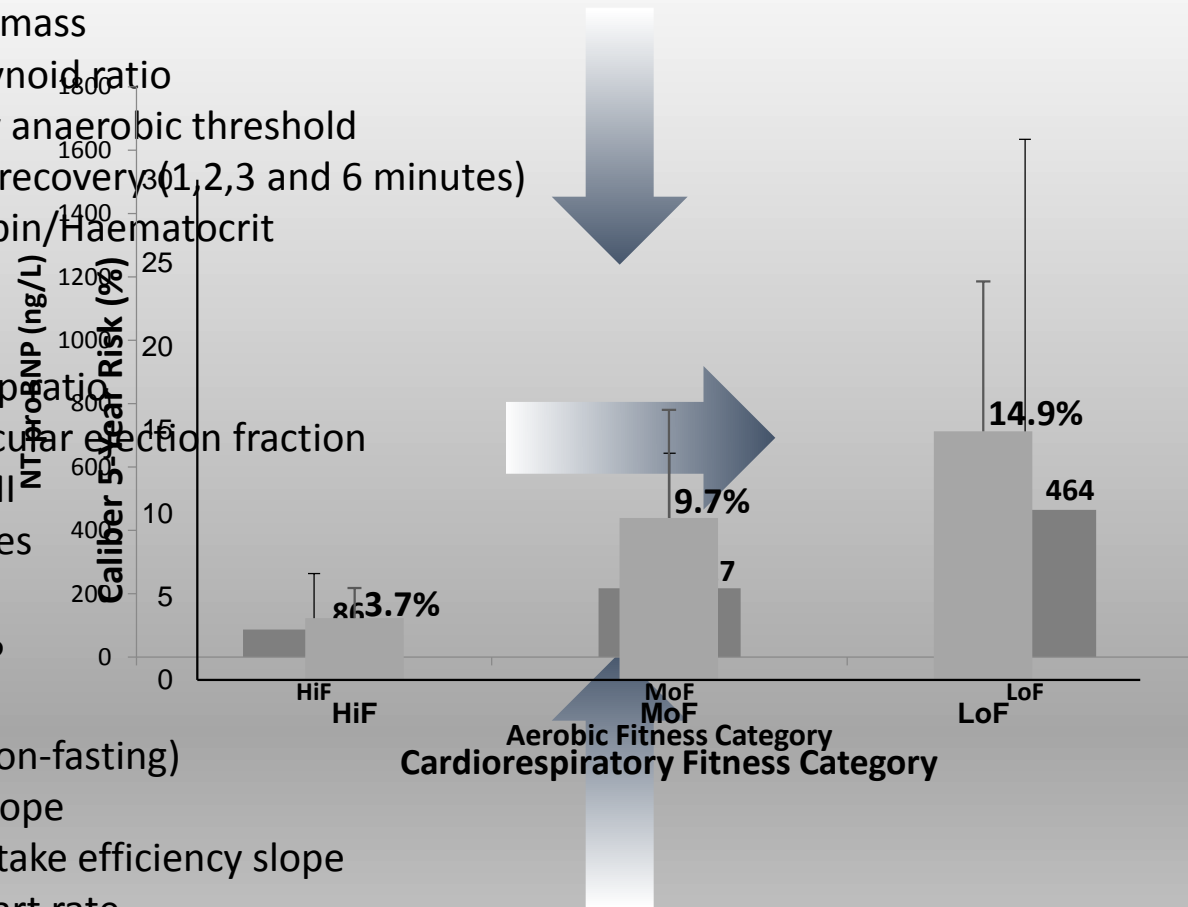
- Kodama *et al.* (2009): ~103,000 patients; demonstrate 1 MET improvement in aerobic fitness confers 13% survival advantage
- Myers *et al.* (2002): ~6200 patients: 1 MET improvement in aerobic fitness confers 12% survival advantage
- Vanhees *et al.* (1995): 1% improvement in exercise training induced $\text{VO}_{2\text{peak}}$ confers a 2% survival advantage in patients with CHD

Low aerobic fitness indicates poor cardiometabolic health - Unpublished

- Lean body mass
- Android/gynoid ratio
- Ventilatory anaerobic threshold
- Heart rate recovery (1, 2, 3 and 6 minutes)
- Haemoglobin/Haematocrit

- BMI
- Waist to hip ratio
- Left ventricular ejection fraction
- Previous MI
- Lipid profiles

- NT-proBNP
- hs-CRP
- Glucose (non-fasting)
- VE/VCO₂ slope
- Oxygen uptake efficiency slope
- Resting heart rate



The Role of HIIT in Cardiac Populations

Exercise-based cardiac rehabilitation for coronary heart disease (Review)

Heran BS, Chen JMH, Ebrahim S, Moxham T, Oldridge N, Rees K, Thompson DR, Taylor RS



THE COCHRANE
COLLABORATION®

Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease

Cochrane Systematic Review and Meta-Analysis

Lindsey Anderson, PhD,* Neil Oldridge, PhD,† David R. Thompson, PhD,‡ Ann-Dorthe Zwisler, MD,§ Karen Rees, PhD,|| Nicole Martin, MA,¶ Rod S. Taylor, PhD*

Changes in cardiorespiratory fitness in cardiac rehabilitation patients: A meta-analysis

Gavin Sandercock*, Valentina Hurtado, Fernando Cardoso

Rehabilitation after myocardial infarction trial (RAMIT): multi-centre randomised controlled trial of comprehensive cardiac rehabilitation in patients following acute myocardial infarction

Robert R West,¹ Dee A Jones,² Andrew H Henderson³

Cardiorespiratory fitness changes in patients receiving comprehensive outpatient cardiac rehabilitation in the UK: a multicentre study

Gavin R H Sandercock,¹ Fernando Cardoso,¹ Meshal Almodhy,¹ Garyfallia Pepera²

The minimum clinically important improvement in the incremental shuttle walk test following cardiac rehabilitation

Linzy Houchen-Wolloff, Sally Boyce and Sally Singh

The Role of HIIT in Cardiac Populations

- Evidence for the application of HIIT in clinical practice is evolving
- There remains a lack of high quality 'pragmatic' real-world evidence
- A major research/logistical challenge in the UK? Prescribing HIIT when maximal exercise testing is not widely available.



@HIITorMISSUK - Study update

Pragmatic multi-centre
RCT – 510 patients

Eight weeks – 2 x per week

10 x high intensity bouts at 85 -
90% PPO

10 x low intensity bouts at 20 -
25% PPO

Control group – standard care
at 40-70% HRR

Assessed following intervention
~8 weeks and at 12 months

Primary outcome measure -
 VO_{2peak}

Also assessing other
physiological, psychosocial and
economic outcomes

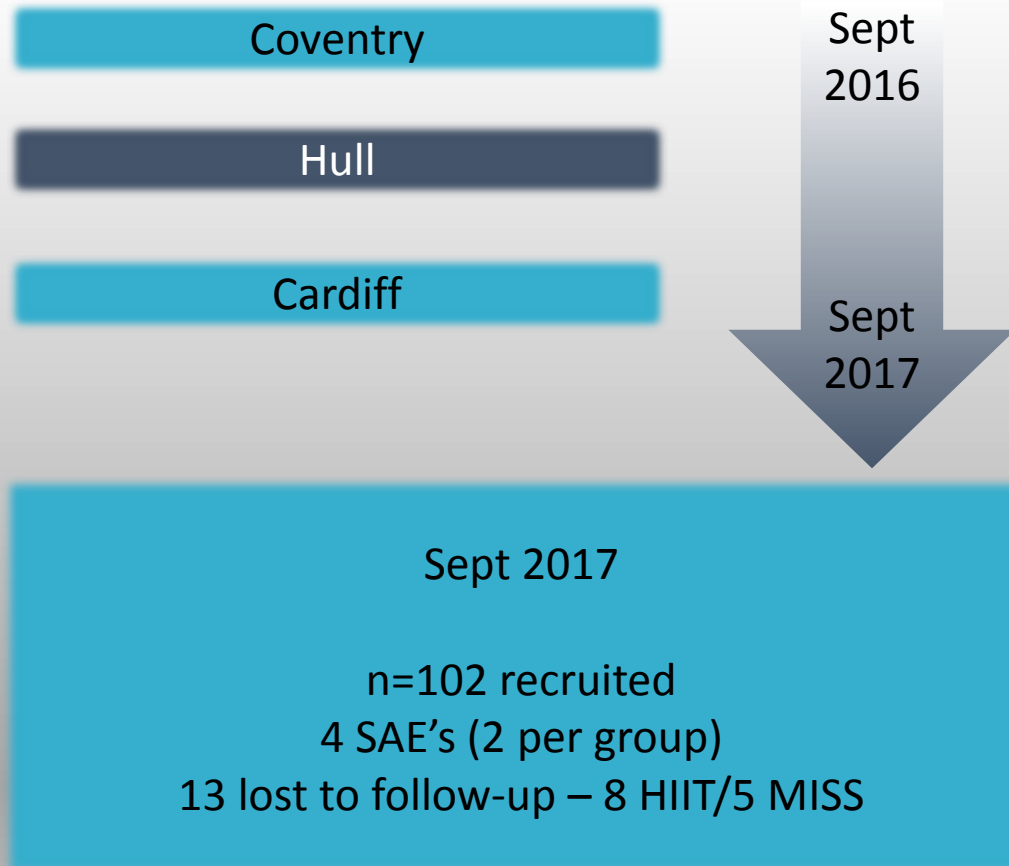
BMJ Open High-intensity interval training versus moderate-intensity steady-state training in UK cardiac rehabilitation programmes (HIIT or MISS UK): study protocol for a multicentre randomised controlled trial and economic evaluation

Gordon McGregor,^{1,2} Simon Nichols,³ Thomas Hamborg,⁴ Lucy Bryning,⁵ Rhiannon Tudor-Edwards,⁵ David Markland,⁶ Jenny Mercer,² Stefan Birkett,³ Stuart Ennis,^{1,2} Richard Powell,¹ Brian Begg,^{2,7} Mark J Haykowsky,⁸ Prithwish Banerjee,^{1,9} Lee Ingle,³ Rob Shave,² Karianne Backx²



@HIITorMISSUK 

@HIITorMISSUK



Have Your Say!

- We would like to understand how UK CR exercise programmes are currently operating.
- At the end of our survey, there is a section relating to the future role that HIIT may have in UK CR programmes.
- We just need one response from each team – Someone directly involved in exercise provision
- <https://northumbria.onlinesurveys.ac.uk/an-evaluation-of-exercise-provision-within-uk-cardiac-reha>

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Summary

- Compared to MISS, HIIT appears to provide superior health benefits
- Variation in HIIT protocols and magnitude of benefit
- HIIT appears to be safe and effective in cardiac populations – HIITorMISSUK may provide much needed ‘real-world’ evidence.



Thank You

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